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## (54) Ink jet recording head and process for forming same

Tintenstrahldruckkopf und sein Herstellungsverfahren

Tête d'enregistrement à jet d'encre et procédé pour sa fabrication

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## Description

The present invention relates to an ink jet recording head and a process for forming same.

There has been known, from Japanese Patent Unexamined Publication No. Sho 58-119870, etc., an ink jet recording head employing a piezoelectric vibrator which moves in the longitudinal direction to apply pressure to ink stored within a pressure chamber, and the pressurized ink is then jetted out from a nozzle as droplets of ink onto a recording medium.

In the recording head of the above-mentioned type, a large number of piezoelectric vibrators are inserted into guide holes formed in the upper and lower portions of a support member to thereby position and support the respective base end portions and leading end portions thereof. However, in this structure, the piezoelectric vibrators cannot be disposed in a high density arrangement. Also, they may be unevenly in the longitudinal direction thereof, and may be inclined with respect to each other, which makes it impossible to provide a uniform ink jet characteristic.

Document EP-A-0 126 649 discloses a fluid jet print head that includes a manifold which defines an elongated cavity, and an orifice plate defining a plurality of orifices. A piezoelectric means is mounted in the cavity and spaced from the orifice plate to define a fluid reservoir therebetween. The transducer arrangement includes also acoustic isolation material such that unwanted wave propagation along the transducer is prevented.

Document JP-A-32 34 538 discloses a method for producing an ink jet recording head in which a plurality of ink chambers are formed by inserting a plurality of teeth of a piezoelectric actuator into a plurality of grooves that are etched into a substrate. The transducer thus produced is formed with a minimal number of assembly steps.

The present invention is directed to eliminating the drawbacks found in the above-mentioned known recording heads. Accordingly, it is an object of the invention to provide a new ink jet recording head which is capable of positioning and connecting a plurality of piezoelectric vibrators, as well as various components forming the recording head, with respect to one another with high accuracy.

This object is solved by the ink jet recording head of independent claim 1 and by the process of independent claim 19. Further advantageous features aspects and details of the invention are evident from the dependent claims, the description and the drawings.

The invention provides an ink jet recording head for use in an ink jet recording device which ejects drops of ink to thereby form an image and, more particularly, an ink jet recording head having a mechanism for precisely positioning the respective components of the head.

In attaining the above object, according to one aspect of the invention, after a plate-shaped piezoelectric element is previously positioned and fixed onto a fixing plate, the piezoelectric element is divided into a plurality of piezoelectric vibrators, and piezoelectric vibrators are held and positioned in the surface direction thereof by a holding device.

According to another aspect of the invention, the outermost piezoelectric vibrators are used as vibrator-positioning members to thereby enhance the working accuracy of the remaining vibrators used for ink jetting. Also, the vibrator-positioning member vibrators are used for positioning the vibrators with respect to the holding device or an ink flow passage substrate.

According to still another aspect of the invention, a pressure chamber in a flow passage substrate is formed in such a manner that both side portions thereof respectively have a plane, and the vibrator-positioning members are respectively opposite to these planar side portions of the ink flow passage substrate, thereby enhancing the positioning accuracy between the ink flow passage forming substrate and the piezoelectric vibrators in the displacement direction thereof.

According to a further aspect of the invention, positioning projections respectively provided on both sides of the fixing plate, which serve as a positioning reference for the piezoelectric vibrators, are used as the positioning portions that position the ink flow passage substrate in the surface direction thereof, so that the piezoelectric vibrators and the ink flow passage substrate can be positioned directly.

Fig. 1 is a sectional side view of an ink jet recording head according to a first embodiment of the invention;

Fig. 2 is a sectional side view of the ink jet recording head, taken from the position of a pin 34;

Figs. 3 (a) to 3(d) are views of a piezoelectric element and a fixing plate, respectively showing steps of producing the piezoelectric vibrators;

Fig. 4 is an explanatory view of a connection relationship between a piezoelectric vibrator and a fixing plate;

Fig. 5 is a plan view of a positioning hole according to a first embodiment of the invention;

Fig. 6 is a plan view of a cavity unit employed in the invention;

Fig. 7 is a sectional view of main portions of the ink jet recording head;

Fig. 8 is a view of a connecting portion between a piezoelectric vibrator and an elastic plate;

Fig. 9 is a sectional view of the ink jet recording head according to another embodiment of the invention;

Fig. 10 is a view of a connecting portion between a piezoelectric vibrator, a fixing plate and a holding frame;

Fig. 11 is a plan view of a piezoelectric vibrator according to third embodiment;

Fig. 12 is a section view of the ink jet recording

head according to fourth embodiment;

Fig. 13 is a sectional view of a fifth embodiment of an ink jet recording head according to the invention;

Figs. 14(a) and 14(b) are sectional views of a sixth embodiment of a cavity unit according to another embodiment; and

Fig. 15 is a sectional view of a seventh embodiment of a cavity unit according to still another embodiment.

Figs. 1 and 2 illustrate an ink jet recording head according to a first embodiment of the invention. The ink jet recording head includes a plate-shaped lamination-type piezoelectric element 1 which, as will be described later, is cut into rectangular pieces which are mounted on a fixing plate 2 to provide a large number of vibrators 11. A holding frame 3 holds the vibrators 11 and positions them in the surface direction of a cavity unit 5. The cavity unit 5 is positioned and held onto the holding frame 3 by a positioning pin 34. Reference numeral 38 denotes a cover which supports the outer peripheral portion of the cavity unit 5. Reference numerals 28 and 29 designates a lead frame; and reference numeral 9 indicates a head circuit board.

Figs. 3(a) to 3(d) and 4 illustrate the piezoelectric element 1 and fixing plate 2. The fixing plate 2 is formed of free-cutting ceramics or the like, and includes an electrode 24 on the top surface thereof. The fixing plate 2 is substantially of a U-shape having positioning portions 22 protruded from both ends thereof. The plate-shaped piezoelectric element 1 has an electrode 14 on the lower surface and the rear end face thereof (see Fig. 4). The piezoelectric element 1 is firmly adhered to the fixing plate 2 in such a manner that the leading edge of the piezoelectric element 1 is protruded from an edge 23 by a given length for keeping an active length L constant, and also the electrode 14 on the lower surface of the element 1 are in contact with the electrode film 24 of the fixing plate 2.

The piezoelectric element 1 is formed to have a width which is greater than the length of a corresponding nozzle array. After it is fixed to the fixing plate 2, the piezoelectric element 1 is sliced into a plurality of vibrators 11, and two vibrator-positioning members 12 each pitch between vibrators having a width corresponding to the pitch of a nozzle 61 (see Fig. 6), by use of a slicing machine such as a wire saw or the like (see Fig. 3(c)). In this case, two rectangular parts respectively formed on the two outermost sides of these vibrators 11 are used as vibrator-positioning members 12. The vibrator positioning members 12 serve to absorb any deformation of the two side ends of the vibrators which occurs during the slicing operation, and to protect the thin vibrators 11.

Also, the electrode 24, disposed on the surface of the fixing plate 2 whose positioning member 22 serves to supplement the vibrator-positioning member, is cut into a large number of signal electrodes 25, which respectively correspond to the vibrators 11, during the slicing operation. The signal electrodes 25 are connected to respective lead wires 29, and the load wires 29 are connected to the head circuit board 9 (see Fig. 1). On the other hand, two common electrodes 26 are respectively connected to the lead frames 28 which extend to the head circuit board 9. A thin conductive film such as flexible cable or metal plate is electrically attached electrode 15 of each vibrators 11 and both ends of film 27 is connected to the common electrodes 26.

Referring again to Figs. 1 and 2, the holding frame 3, which positions and holds the vibrators 11 and the fixing plate 2, is formed of an epoxy resin or other material in a cylindrical shape having a skirt like portion 31 which fans out at the bottom. The skirt like portion 31, more particularly, the interior of the skirt portion 31, receives the respective lead wires 28 and 29, and the head circuit board 9 is mounted onto the bottom of the skirt like portion 31 in a stable manner.

In the drawings, reference numeral 36 designates an inclined guide surface which is formed so as to taper toward the positioning hole 33 so as to facilitate the insertion of the piezoelectric element 1.

The holding frame 3, which holds the piezoelectric element 1 and the fixing plate 2, has a positioning hole 33 on the top surface 32 (see Figs. 1 and 5). The positioning hole 33 includes a wide portion 33a into which the fixing plate 2 can be fitted with a slight clearance $\delta 1$ in the thickness direction thereof, and a narrow portion 33b into which the vibrators 11 can be fitted with a slight clearance $\delta 2$ in the width direction thereof. The wide portion 33a is used to position the fixing plate 2 in the thickness direction, and also the narrow portion 33b is used to position the piezoelectric vibrators 11 in the width direction thereof, whereby the piezoelectric vibrators 11 can be accurately positioned in the surface direction of the cavity unit 5.

As illustrated in Fig. 7, the cavity unit 5 to be positioned and held on the top surface 32 of a holding frame 3 with a positioning pin 34 includes a nozzle plate 6 having a nozzle 61 formed therein, a flow passage plate 7 defining an ink flow passage, and in elastic plate 8.

As shown in Fig. 6, the nozzle plate 6 employed in the present embodiment includes two sets of nozzles, each set consisting of two arrays of nozzles, each array consisting of 12 nozzles 61 (only some of which are indicated). It should be noted that the vibrator-positioning member 12 do not have a nozzle associated therewith. Also, the flow passage plate 7 which is formed of a photo-curable resin is placed on the nozzle plate 6. The flow passage plate 7 includes 4 arrays of pressure chambers, each array consisting of 12 pressure chambers 72. Each of the pressure chambers 72, which are formed in a rectangular shape, are in communication with a common ink chamber 71. Specifically, the nozzles 61 are respectively in communication with the ends of the pressure chambers 72 which are disposed so as

to correspond thereto.

Also, the elastic plate 8, which is placed on the surface of the flow passage plate 7, is formed of a thin plate such as an electroforming nickel product or the like. The elastic plate 8 includes a plurality of ring-shaped thin portions 81 which extend along the inner edges of the respective pressure chambers 72. Further, as shown in Fig. 8, in the portions of the elastic plate 8 surrounded by the thin portions 81, there are formed high ridid thick portions 82 which abut against the leading ends of the vibrators 11. Each of the thick portions 82 is arranged such that it has a width smaller than the thickness of the vibrator 11.

The thin portions 81 and the thick portions 82 can be formed separately from each other. Alternatively, the thick portions 82 may be formed by forming a plating or a resin layer on a thin film 81.

As shown in Figs. 2 and 6, if recessed or holed portions 51 respectively formed in the cavity unit 5 are fitted with two positioning pins 34 respectively projecting from the top surface of the holding frame 3 to thereby position the cavity unit 5 relative to the holding frame 3 accurately. Also, as shown in Fig. 1, the respective leading ends of the vibrator-positioning member 12 provided on both outermost portions of the vibrators 11 are abutted against flat surfaces 73 of the elastic plate 8 disposed on both sides of the pressure chamber 72 so that the cavity unit 5 and the vibrators 11 are positioned accurately in a direction along which the vibrators 11 are displaced.

In the ink jet recording head constructed in the above-mentioned manner, the piezoelectric element 1 is bounded to the fixing plate 2 such that the front edge of the element 1 is projected out to a given length from an edge 23 of the fixing plate 2 (see Figs. 3(a) and 3(b)). Subsequently, the piezoelectric element 1 is cut and divided into a large number of portions to thereby provide 12 vibrators 11 and two vibrator-positioning members 12.

Next, the piezoelectric element 1 or fixing plate 2 must be strongly fixed to holding frame 3 by interposing an adhesive in the clearance of the holding frame 3 in order to control the vibratory movements of the fixing plate 2. An epoxy adhesive having an excellent fusing property is desirable when the holding frame is formed of in epoxy resin and the fixing plate 2 is formed of a ceramics.

When such an adhesive is heated so that it can be quickly hardened, the leading ends of the vibrators 11 draw back or draw out with reference to the top surface of the holding frame 3 due to the different materials and shapes between vibrators 11 and the fixing plate 2, the holding frame 3. For this reason, in the present embodiment, as shown in Fig. 10, a UV-curing adhesive a is at first coated on the connecting portion as a provisional adhesive. That is, the UV adhesive a is applied to the connecting portion and then is irradiated with ultraviolet rays to be hardened. Subsequently, an epoxy adhesive b is injected between the holding frame 3 and the fixing plate 2 to thereby firmly bond the fixing plate 2 to the holding frame 3 under lower temperature or room temperature. The cavity unit 5 is then mounted in such a manner that the recessed portions 51 thereof are engaged with the respective positioning pins 34 projecting from the holding frame 3. Next, outside of two vibrator-positioning member 12 are fitted into the positioning hole 33 formed in the top surface 32 of the holding frame 3 to thereby position the vibrators 11 in the widthwise direction thereof. At the same time, the vibrators 11 are positioned in the thickness direction thereof by means of the fixing plate 2. Further, the respective leading end portions of the vibrator-positioning member 12 are abutted against the flat surface 73 provided on both sides of each pressure chambers array through the elastic plate 8, thereby positioning the vibrators 11 and the cavity unit 5 in the displacement direction thereof.

Fig. 9 illustrates another embodiment of the invention, which relates to the positioning of the vibrators 11 and the cavity unit 5 in the displacement direction. In this embodiment, intead of the vibrator-positioning member 12 used in the above-mentioned embodiment, the positioning member 22 on the leading end of the fixing plate 2 is abutted against a positioning step 35 of the holding frame 3 so that the vibrators 11 is positioned in the displacement direction with accuracy.

Fig. 11 illustrates a third embodiment of the invention, which relates to the mutual positioning of the vibrators 11 and the cavity unit 5. In this embodiment, the widths of the vibrator-positioning member 12 to be provided on the two outermost sided of the vibrators 11 are widened and slits 13 are formed at the accurate position with reference to the vibrators in the leading end faces thereof, so that the positioning pins provided on the lower surface of the elastic plate 8 can be fitted into the slits 13, respectively.

According to the third embodiment, the vibrators 11 and the cavity unit 5 are directly connected to each other to thereby be able to enhance their mutual positioning accuracy in the surface direction.

Fig. 12 illustrates a fourth embodiment, which relates to the positioning of the vibrators 11 and cavity unit 5. In the fourth embodiment, the front edge of a plate-shaped piezoelectric element 1 is arranged so as to project a distance which corresponds to the leading ends of two positioning portions 22 provided on the two sides of a fixing plate 2, and then the piezoelectric element 1 and the fixing plate 2 are bonded to each other. Subsequently, the piezoelectric element 1 is cut and divided into a large number of vibrators 11, so that the leading ends of the respective vibrators 11 can be matched to the positioning portions 22 with accuracy.

According to this embodiment, the vibrators 11 are positioned in surface direction using slit 21 and pin 51, and positioned in displace direction when placing ends of the positioning portions 22 with the elastic place 8.

Fig. 13 illustrates a fifth embodiment of the inven-

tion in which the front edge of a piezoelectric element 1 is projected out a slight length g beyond the leading ends of two positioning portions 22 respectively provided on the two side portions of a fixing plate 2 and then the piezoelectric element 1 and fixing plate 2 are bonded to each other. Subsequently, the piezoelectric element 1 is cut and divided into a large number of vibrators 11. According to the fifth embodiment, when a cavity unit 5 is mounted to the leading ends of the two positioning portions 22, which function as a reference for positioning, on the two side portions of the fixing plate 2, then the leading ends of the vibrators 11 are strongly abutted against an elastic plate 8 in such a manner that the elastic plate 8 is slightly flexed toward a pressure chamber 72. Accordingly, the thickness of an adhesive to be applied to the leading ends of the vibrators 11 can be reduced. Alternatively, this may be omitted.

Figs. 14(a) and 14(b) illustrate a sixth embodiment of a cavity unit 5 according to the invention. In the sixth embodiment, the chamber partation wall 77 of the flow passage plate 7, which defines an ink flow passage, is composed of a thick layer 74 and a thin layer 75, and the thick layer 74 is arranged to have a wide width W1 and the thin layer 75 is arranged to have a narrow width W2.

According to the sixth embodiment, even if the two layers 74 and 75 are slightly shifted in position in the surface direction thereof when they are connected together in the manufacturing process, as shown in Fig. 14(b), the area of the connecting surface thereof remains unchanged so that the rigidity of the wall 77 can be maintained. Also, by uniformly setting a ratio T/W of the thicknesses T1, T2 and widths W1, W2 of the two layers 74, 75, the rigidity is enhanced to thereby ensure stable ink jetting.

According to this embodiment, there is a still more advantage that one can keep a wide span W3 of the pressure chamber without decreasing a ridigity of wall, then one can get a large volume of ink droplet even if in the case of high density pressure chamber.

Fig. 15 illustrates a seventh embodiment in which a flow passage plate 7 is composed of three layers 74, 75, 76, and the width W2 of the middle layer 75 is set narrower than those of the remaining layers. Accordingly, even if the three layers are shifted in the surface direction thereof when they are connected together, the strength and rididity of the wall can be maintained constant.

## Claims

1. An ink jet recording head wherein the movement of a piezoelectric element moves part of an ink flow passage substrate so as to jet out ink stored therein in the form of ink droplets, said ink jet recording head comprising:

   a fixing plate (2);

   a plurality of piezoelectric vibrators (11) fixed to said fixing plate (2) and obtainable by cutting and dividing a plate-shaped piezoelectric element (1) while said plate-shaped piezoelectric element (1) is fixed on said fixing plate (2);

   holding means (3) which holds and positions said fixing plate (2) and at least one of said piezoelectric vibrators (11) in the directions perpendicular to the displacement direction of said piezoelectric vibrators (11);

   an ink flow passage substrate (5) mounted on said holding means (3) so as to regulate the relative position thereof and including a nozzle plate (6), an ink flow passage forming plate (7) and an elastic plate (8) connected with one or more of said piezoelectric vibrators (11); and a vibrator-positioning member (12; 22) coupled with said ink flow passage substrate (5) to position said piezoelectric vibrators (11) in a displacement direction thereof.

2. An ink jet recording head as set forth in Claim 1 wherein a front edge of said plate-shaped piezoelectric element (1) is positioned and fixed relative to at least one of positioning projections (22) disposed on the two sides of said fixing plate (2).

3. An ink jet recording head as set forth in Claim 2, wherein said positioning projections (22) are engaged with portions of said ink flow passage substrate (5) so as to position said ink flow passage substrate (5) relative to said piezoelectric vibrators (11) in directions along a plane defined by said ink flow passage substrate.

4. An ink jet recording head as set forth in any one of the preceding claims, wherein selected ones of said piezoelectric vibrators (11) are used as said vibrator-positioning members (12) which are coupled to portions of said ink flow passage substrate (5).

5. An ink jet recording head as claimed in any of the preceding claims, wherein said vibrator-positioning members (12) are respectively situated on both sides of said plurality of piezoelectric vibrators (11).

6. An ink jet recording head as set forth in any of the preceding claims, wherein leading ends of said vibrator-positioning member (12) are engaged with said ink flow passage substrate (5) so as to define a relative position between said ink flow passage substrate and said piezoelectric vibrators (11).

7. An ink jet recording head as set forth in any one of the preceding claims, further comprising:

   a signal electrode (25) formed on each of said piezoelectric vibrators (11).

8. An ink jet recording head as set forth in any one of the preceding claims, wherein positioning portions are formed on a top surface (32) of said holding means (3), said positioning portions being engaged with said piezoelectric vibrators (11), so as to define a relative position between said holding means and said piezoelectric vibrators (11).

9. An ink jet recording head as set forth in any one of the preceding claims, wherein an epoxy adhesive (b) combined with an adhesive (a) of an ultraviolet-curable type is inserted in a connecting portion gap defined between said holding means (3) and said fixing plate (2).

10. An ink jet recording head as set forth in any one of the preceding claims, wherein said vibrator-positioning members (12) are coupled with said ink flow passage substrate (5) on both sides of an array of ink chambers (72) defined therein.

11. An ink jet recording head as set forth in any one of the preceding claims, wherein said ink flow passage substrate (5) includes an ink flow passage forming plate (7), said flow passage forming plate (7) is composed of at least two layers (74, 75) and the widths (W1, W2) of the partition walls (77) which define ink flow passages respectively formed in said respective layers (74, 75) are different from one another.

12. An ink jet recording head as set forth in any one of the preceding claims, wherein a flat layer is formed on the surface of said elastic plate (8), said flat layer being in contact with said piezoelectric vibrators (11) and said ink flow passage substrate (5), said piezoelectric vibrators being connected with each other by virtue of said flat layer.

13. An ink jet recording head as set forth in any one of the preceding claims, wherein said plurality of piezoelectric vibrators (11) constitutes a vibrator set, said holding means (3) positioning and holding a plurality of vibrator sets.

14. An ink jet recording head as claimed in any one of the preceding claims, further comprising an electrode (24) formed on said fixing plate (2), said electrode being divided together with said plate-shaped piezoelectric element (1) to provide a plurality of signal electrodes (25) corresponding to said piezoelectric vibrators (11), respectively.

15. An ink jet recording head as claimed in any one of the preceding claims, wherein said holding means (3) and said vibrator-positioning member (12) position said piezoelectric vibrators (11) in a widthwise direction thereof, and said holding means (3) and said fixing plate (2) position said piezoelectric vibrators (11) in a thickness direction thereof.

16. An ink jet recording head as claimed in any one of the preceding claims, wherein said piezoelectric vibrators (11) comprise multi-layer piezoelectric vibrators.

17. An ink jet recording head as claimed in any one of the preceding claims, wherein said fixing plate (2) reinforces said vibrator-positioning member (12).

18. An ink jet recording head as set forth in any of the preceding claims, further comprising a positioning member (34) engaged with said ink flow passage substrate (5) and said holding means (3) so as to regulate the relative position thereof.

19. A process for forming an ink jet recording head wherein the movement of a piezoelectric element moves part of an ink flow passage substrate so as to jet out ink stored therein, said process comprising the steps of:

attaching a plate-shaped piezoelectric element (1) to a fixing plate (2),

cutting said plate-shaped piezoelectric element (1) into a plurality of piezoelectric vibrators (11),

inserting said piezoelectric vibrators (11), mounted on said fixing plate (2) into a holding means (3), and fixing at least one of said piezoelectric vibrators (11) and said fixing plate (2) to said holding means (3),

mounting an ink flow passage substrate (5) on said holding means (3) so as to be in contact with said piezoelectric vibrators (11),

engaging a positioning member with said ink flow passage substrate (5) and said holding means (3) so as to regulate the relative position thereof.

20. The process according to claim 19, wherein said step of mounting said ink flow passage substrate (5) on said holding means (3) is performed before said step of inserting said piezoelectric vibrators (11) into said holding means (3).

21. The process according to claim 19 or 20, said process further comprising the step of coupling a vibrator-positioning member (12) with said ink flow passage substrate (5) to position said piezoelectric vibrators (11) in a displacement direction thereof.

22. The process according to any of claims 19 to 21, said process further comprising the steps of: widening widths of a vibrator-positioning member to be provided on the two outermost sides of said piezoelectric vibrators, forming slits in leading end faces of said vibrators, fitting an elastic plate into said slits.

23. The process according to any of claims 19 to 21, said process further comprising the steps of:

arranging a front edge of a plate-shaped piezoelectric element so as to project a distance which corresponds to leading ends of two positioning portions provided on the two sides of a fixing plate,
bonding said plate-shaped piezoelectric element and said fixing plate to each other, and
cutting and dividing said plate-shaped piezoelectric element into a large number of vibrators so that leading ends of said respective vibrators are matched to said positioning portions with accuracy.

**Patentansprüche**

1. Tintenstrahlaufzeichnungskopf, bei dem aufgrund der Bewegung eines piezoelektrischen Elements ein Teil eines Tintendurchfluß-Substrats derart bewegt wird, daß in diesem gespeicherte Tinte in Form von Tintentröpfchen ausgestoßen wird, wobei der Tintenstrahlaufzeichnungskopf umfaßt:

eine Fixierplatte (2),
eine Vielzahl an der Fixierplatte (2) befestigte piezoelektrische Vibratoren (11), welche mittels Schneiden und Teilen eines plattenförmigen piezoelektrischen Elements (1) erhältlich sind während das plattenförmige piezoelektrische Element (1) auf der Fixierplatte (2) befestigt ist,
ein Haltemittel (3), welches die Fixierplatte (2) und wenigstens einen der piezoelektrischen Vibratoren (11) in den Richtungen senkrecht zur Bewegungsrichtung der piezoelektrischen Vibratoren (11) hält und positioniert,
ein Tintendurchfluß-Substrat (5), welches derart auf dem Haltemittel (3) befestigt ist, daß dessen relative Position reguliert wird, und eine Düsenplatte (6), eine einen Tintendurchgang bildende Platte (7) sowie eine mit einem oder mehreren der piezoelektrischen Vibratoren (11) verbundene elastische Platte (8) enthält, und
ein Vibratorpositionierelement (12;22), welches derart mit dem Tintendurchfluß-Substrat (5) verbunden ist, daß die piezoelektrischen Vibratoren (11) in einer Bewegungsrichtung von diesen positioniert ist.

2. Tintenstrahlaufzeichnungskopf gemäß Anspruch 1, bei dem eine vordere Kante des plattenförmigen piezoelektrischen Elements (1) relativ zu wenigstens einem von Positoniervorsprüngen (22), die auf den beiden Seiten der Fixierplatte (2) angeordnet sind, positioniert und befestigt ist.

3. Tintenstrahlaufzeichnungskopf gemäß Anspruch 2, bei dem die Positioniervorsprünge (22) sich derart in Eingriff mit Bereichen des Tintendurchfluß-Substrats (5) befinden, daß das Tintendurchfluß-Substrat (5) relativ zu den piezoelektrischen Vibratoren (11) in Richtungen entlang einer Ebene, welche durch das Tintendurchflußsubstrat definiert ist, positioniert ist.

4. Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem bestimmte piezoelektrische Vibratoren (11) als Vibratorpositionierelemente (12) verwendet werden, welche mit Bereichen des Tintendurchfluß-Substrats (5) verbunden sind.

5. Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem die Vibratorpositionierelemente (12) jeweils auf beiden Seiten der Vielzahl von piezoelektrischen Vibratoren (11) angeordnet sind.

6. Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem vordere Enden des Vibratorpositionierelements (12) sich derart in Eingriff mit dem Tintendurchfluß-Substrat (5) befinden, daß eine relative Position zwischen dem Tintendurchfluß-Substrat und den piezoeletkischen Vibratoren (11) festgelegt ist.

7. Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, der des weiteren umfaßt:

eine auf jedem der piezoelektrischen Vibratoren (11) ausgebildeten Signalelektrode (25).

8. Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem die Positonierbereiche auf einer oberen Fläche (32) des Haltemittels (3) ausgebildet sind, wobei die Positonierbereiche derart mit den piezoelektrischen Vibratoren (11) in Eingriff stehen, daß sie eine relative Position zwischen dem Haltemittel und den piezoelektrischen Vibratoren (11) festlegen.

9. Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem ein Epoxyhaftmittel (b) in Kombination mit einem Haftmittel

(a), welches mit ultraviolettem Licht aushärtbar ist, in einen zwischen dem Haltemittel (3) und der Fixierplatte (2) gebildeten Verbindungsbereichspalt eingefügt ist.

**10.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehen Ansprüche, bei dem die Vibratorpositionierelemente (12) mit dem Tintendurchfluß-Substrat (5) auf beiden Seiten einer darin ausgebildeten Anordnung von Tintenkammern (72) verbunden sind.

**11.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem das Tintendurchfluß-Substrat (5) eine einen Tintendurchgang bildende Platte (7) aufweist, wobei die einen Tintendurchgang bildende Platte (7) aus wenigstens zwei Schichten (74,75) aufgebaut ist und die Breiten (W1, W2) der Trennwände (77), welche jeweils in entsprechenden Schichten (74,75) ausgebildete Tintendurchgänge festlegen, unterschiedlich sind.

**12.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem eine flache Schicht auf der Oberfläche der elastischen Platte (8) ausgebildet ist, wobei die flache Schicht die piezoelektrischen Vibratoren (11) und das Tintendurchfluß-Substrat (5) berührt und die piezoelektrischen Vibratoren miteinander durch die flache Schicht verbunden sind.

**13.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem die Vielzahl von piezoelektrischen Vibratoren (11) ein Vibratorsatz darstellt, wobei das Haltemittel (3) eine Vielzahl von Vibratorsätzen positoniert und hält.

**14.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, der des weiteren eine auf der Fixierplatte (2) ausgebildete Elektrode (24) aufweist, wobei die Elektrode zusammen mit dem plattenförmigen piezoelektrischen Element (1) geteilt ist, um jeweils entsprechend den piezoelektrischen Vibrtoren (11) eine Vielzahl von Signalelektroden (23) zu bilden.

**15.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem das Haltemittel (3) und das Vibratorpositionierelement (12) die piezoelektrischen Vibratoren (11) in eine Breitenrichtung von diesen positionieren und das Haltemittel (3) und die Fixierplatte (2) die piezoelektrischen Vibratoren (11) in einer Dickenrichtung davon positionieren.

**16.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem die piezoelektrischen Vibratoren (11) vielschichtige piezoelektrische Vibratoren umfassen.

**17.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, bei dem die Fixierplatte (2) das Vibratorpositionierelement (12) verstärkt.

**18.** Tintenstrahlaufzeichnungskopf gemäß einem der vorhergehenden Ansprüche, der des weiteren ein Positonierelement (34) umfaßt, welches mit dem Tintendurchfluß-Substrat (5) und dem Haltemittel (3) derart in Eingriff steht, um dessen relative Position zu regulieren.

**19.** Verfahren zur Bildung eines Tintenstrahlaufzeichnungskopfes, bei dem aufgrund der Bewegung eines piezoelektrischen Elements ein Teil eines Tintendurchfluß-Substrats derart bewegt wird, daß darin gespeicherte Tinte ausgestoßen wird, wobei das Verfahren die folgenden Schritte umfaßt:

Befestigen eines plattenförmigen piezoelektrischen Elements (1) an einer Fixierplatte (2),

Schneiden eines plattenförmigen piezoelektrischen Elements (1) in eine Vielzahl von piezoelektrischen Vibratoren (11),

Einsetzen der auf der Fixierplatte (2) befestigten piezoelektrischen Vibratoren (11) in ein Haltemittel (3) und Befestigen wenigstens eines der piezoelektrischen Vibratoren (11) und der Fixierplatte (2) an dem Haltemittel (3),

Montieren eines Tintendurchfluß-Substrats (5) auf dem Haltemittel (3), so daß dieses die piezoelektrischen Vibratoren (11) berührt,

in Eingriff bringen eines Positionierelements mit dem Tintendurchfluß-Substrat (5) und dem Haltemittel (3), um dessen relative Position zu regulieren.

**20.** Verfahren gemäß Anspruch 19, bei dem der Schritt des Montierens des Tintendurchfluß-Substrats (5) auf dem Haltemittel (3) vor dem Schritt des Einsetzens der piezoelektrischen Vibratoren (11) in das Haltemittel (3) durchgeführt wird.

**21.** Verfahren gemäß Anspruch 19 oder 20, wobei das Verfahren als weiteren Schritt das Verbinden eines Vibratorpositionierelements (12) mit dem Tintendurchfluß-Substrat (5) zur Positionierung der piezoelektrischen Vibratoren (11) in einer Bewegungsrichtung von diesen umfaßt.

**22.** Verfahren gemäß einem der Ansprüche 19 bis 21, wobei das Verfahren des weiteren die folgenden

Schritte umfaßt: Erweitern der Breiten eines Vibratorpositionierelements, welches auf den zwei äußersten Seiten der piezoelektrischen Vibratoren auszubilden ist, Ausbilden von Schlitzen in den vorderen Endflächen der Vibratoren, Einfügen einer elastischen Platte in die Schlitze.

**23.** Verfahren gemäß einem der Ansprüche 19 bis 21, wobei das Verfahren des weiteren die folgenden Schritte umfaßt:

Anordnen einer vorderen Kante eines plattenförmigen piezoelektrischen Elements derart, daß es um eine Strecke herausragt, welche den vorderen Enden von zwei auf den beiden Seiten einer Fixierplatte angeordneten Positionierbreichen entspricht,
Verbinden des plattenförmigen piezoelektrischen Elements und der Fixierplatte miteinander, und
Schneiden und Teilen des plattenförmigen piezoelektrischen Elements in eine große Anzahl von Vibratoren, so daß die vorderen Enden der jeweiligen Vibratoren den Positionierbereichen genau entsprechen.

**Revendications**

**1.** Tête d'enregistrement à jets d'encre, dans laquelle le déplacement d'un élément piézoélectrique provoque un déplacement d'une partie d'un substrat à passages de circulation d'encre afin que de l'encre conservée dans le passage soit projetée sous forme de gouttelettes d'encre, la tête d'enregistrement à jets d'encre comprenant :

une plaque (2) de fixation,
plusieurs vibrateurs piézoélectriques (11) fixés à la plaque (2) de fixation et qui peuvent être obtenus par découpe et division d'un élément piézoélectrique (1) en forme de plaque alors que l'élément piézoélectrique (1) en forme de plaque est fixé sur la plaque (2) de fixation,
un dispositif (3) de maintien et de positionnement de la plaque (2) de fixation et de l'un au moins des vibrateurs piézoélectriques (11) en directions perpendiculaires à la direction de déplacement des vibrateurs piézoélectriques (11),
un substrat (5) à passages de circulation d'encre monté sur le dispositif (3) de maintien pour la régulation de leur position relative et comprenant une plaque (6) à buses, une plaque (7) de formation de passages de circulation d'encre et une plaque élastique (8) raccordées à un ou plusieurs des vibrateurs piézoélectriques (11), et
un organe (12 ; 22) de positionnement de vibrateurs couplé au substrat (5) à passages de circulation d'encre afin que les vibrateurs piézoélectriques (11) soient positionnés dans une direction de déplacement de ceux-ci.

**2.** Tête d'enregistrement à jets d'encre selon la revendication 1, dans laquelle le bord avant de l'élément piézoélectrique (1) en forme de plaque est positionné et fixé par rapport à l'une au moins des saillies (22) de positionnement disposées des deux côtés de la plaque (2) de fixation.

**3.** Tête d'enregistrement à jets d'encre selon la revendication 2, dans laquelle les saillies de positionnement (22) coopèrent avec des parties du substrat (5) à passages de circulation d'encre de manière que le substrat (5) à passages de circulation d'encre soit positionné par rapport aux vibrateurs piézoélectriques (11) dans des directions comprises dans un plan délimité par le substrat à passages de circulation d'encre.

**4.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle des vibrateurs choisis parmi les vibrateurs piézoélectriques (11) sont utilisés comme organes (12) de positionnement de vibrateurs qui sont couplés à des parties du substrat (5) à passages de circulation d'encre.

**5.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle les organes (12) de positionnement de vibrateurs sont placés respectivement des deux côtés des vibrateurs piézoélectriques (11).

**6.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle les extrémités antérieures de l'organe (12) de positionnement de vibrateurs sont en coopération avec le substrat (5) à passages de circulation d'encre pour la délimitation d'une position relative entre le substrat à passages de circulation d'encre et les vibrateurs piézoélectriques (11).

**7.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, comprenant en outre une électrode (25) de signaux formée sur chacun des vibrateurs piézoélectriques (11).

**8.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle des parties de positionnement sont formées sur une surface supérieure (32) du dispositif de maintien (3), les parties de positionnement étant en coopération avec les vibrateurs piézoélectriques (11) afin qu'elles délimitent une position relative

entre le dispositif de maintien et les vibrateurs piézoélectriques (11).

**9.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle un adhésif époxyde (b) combiné à un adhésif (a) du type qui polymérise sous l'action des ultraviolets est introduit dans un espace de partie de raccordement délimité entre le dispositif de maintien (3) et la plaque (2) de fixation.

**10.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle les organes (16) de positionnement de vibrateurs sont couplés au substrat (5) à passages de circulation d'encre des deux côtés d'un arrangement de chambres (72) d'encre délimitées à l'intérieur du substrat.

**11.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle le substrat (5) à passages de circulation d'encre comprend une plaque (7) formant des passages de circulation d'encre, cette plaque (7) formant des passages de circulation d'encre étant composée d'au moins deux couches (74, 75) et les largeurs (W1, W2) des parois de séparation (77) qui délimitent les passages de circulation d'encre formés respectivement dans les couches respectives (74, 75) sont différentes.

**12.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle une couche plate est formée à la surface de la plaque élastique (8), la couche plate étant au contact des vibrateurs piézoélectriques (11) et du substrat (5) à passages de circulation d'encre, les vibrateurs piézoélectriques étant connectés mutuellement par la couche plate.

**13.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle les vibrateurs piézoélectriques (11) constituent un ensemble de vibrateurs, le dispositif (3) de maintien positionnant et maintenant plusieurs ensembles de vibrateurs.

**14.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, comprenant en outre une électrode (24) formée sur la plaque (2) de fixation, l'électrode étant divisée avec l'élément piézoélectrique (1) en forme de plaque pour la réalisation de plusieurs électrodes (25) de signaux qui correspondent respectivement aux vibrateurs piézoélectriques (11).

**15.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle le dispositif (3) de maintien et l'organe (12) de positionnement de vibrateurs positionnent les vibrateurs piézoélectriques (11) dans la direction de leur largeur, et le dispositif (3) de maintien et la plaque (2) de fixation positionnent les vibrateurs piézoélectriques (11) dans la direction de leur épaisseur.

**16.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle les vibrateurs piézoélectriques (11) sont des vibrateurs piézoélectriques multicouches.

**17.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, dans laquelle la plaque (2) de fixation renforce l'organe (12) de positionnement de vibrateurs.

**18.** Tête d'enregistrement à jets d'encre selon l'une quelconque des revendications précédentes, comprenant en outre un organe (34) de positionnement qui coopère avec le substrat (5) à passages de circulation d'encre et le dispositif (3) de maintien afin que leur position relative soit régulée.

**19.** Procédé de formation d'une tête d'enregistrement à jets d'encre, dans laquelle le déplacement d'un élément piézoélectrique déplace une partie d'un substrat à passages de circulation d'encre afin que de l'encre conservée dans un passage soit projetée, le procédé comprenant les étapes suivantes :

la fixation d'un élément piézoélectrique (1) en forme de plaque à une plaque (2) de fixation,
la découpe de l'élément piézoélectrique (1) en forme de plaque en plusieurs vibrateurs piézoélectriques (11),
l'insertion des vibrateurs piézoélectriques (11) montés sur la plaque (2) de fixation dans un dispositif (3) de maintien, et la fixation de l'un au moins des vibrateurs piézoélectriques (11) et de la plaque (2) de fixation sur le dispositif (3) de maintien,
le montage d'un substrat (5) à passages de circulation d'encre sur le dispositif (3) de maintien afin qu'il soit au contact des vibrateurs piézoélectriques (11), et
la mise en contact d'un organe de positionnement avec le substrat (5) à passages de circulation d'encre et le dispositif (3) de maintien afin que leur position relative soit réglée.

**20.** Procédé selon la revendication 19, dans lequel l'étape de montage du substrat (5) à passages de circulation d'encre sur le dispositif (3) de maintien est réalisée avant l'étape d'insertion des vibrateurs piézoélectriques (11) dans le dispositif de maintien (3).

**21.** Procédé selon la revendication 19 ou 20, comprenant en outre une étape d'accouplement d'un organe (12) de positionnement de vibrateurs au substrat (5) à passages de circulation d'encre afin que les vibrateurs piézoélectriques (11) soient positionnés dans leur direction de déplacement.

**22.** Procédé selon l'une quelconque des revendications 19 à 21, comprenant les étapes suivantes : l'élargissement des largeurs d'un organe de positionnement de vibrateurs destiné à être placé sur les deux côtés externes des vibrateurs piézoélectriques, la formation de fentes aux faces d'extrémités avant des vibrateurs, et le montage d'une plaque élastique dans les fentes.

**23.** Procédé selon l'une quelconque des revendications 19 à 21, comprenant les étapes suivantes :

la disposition d'un bord avant d'un élément piézoélectrique en forme de plaque afin qu'il dépasse d'une distance qui correspond aux extrémités avant des deux parties de positionnement formées sur les deux côtés d'une plaque de fixation,
le collage de l'élément piézoélectrique en forme de plaque et de la plaque de fixation l'un à l'autre, et
la découpe et la division de l'élément piézoélectrique en forme de plaque en un grand nombre de vibrateurs afin que les extrémités avant des vibrateurs respectifs correspondent aux parties de positionnement avec précision.

FIG. 1

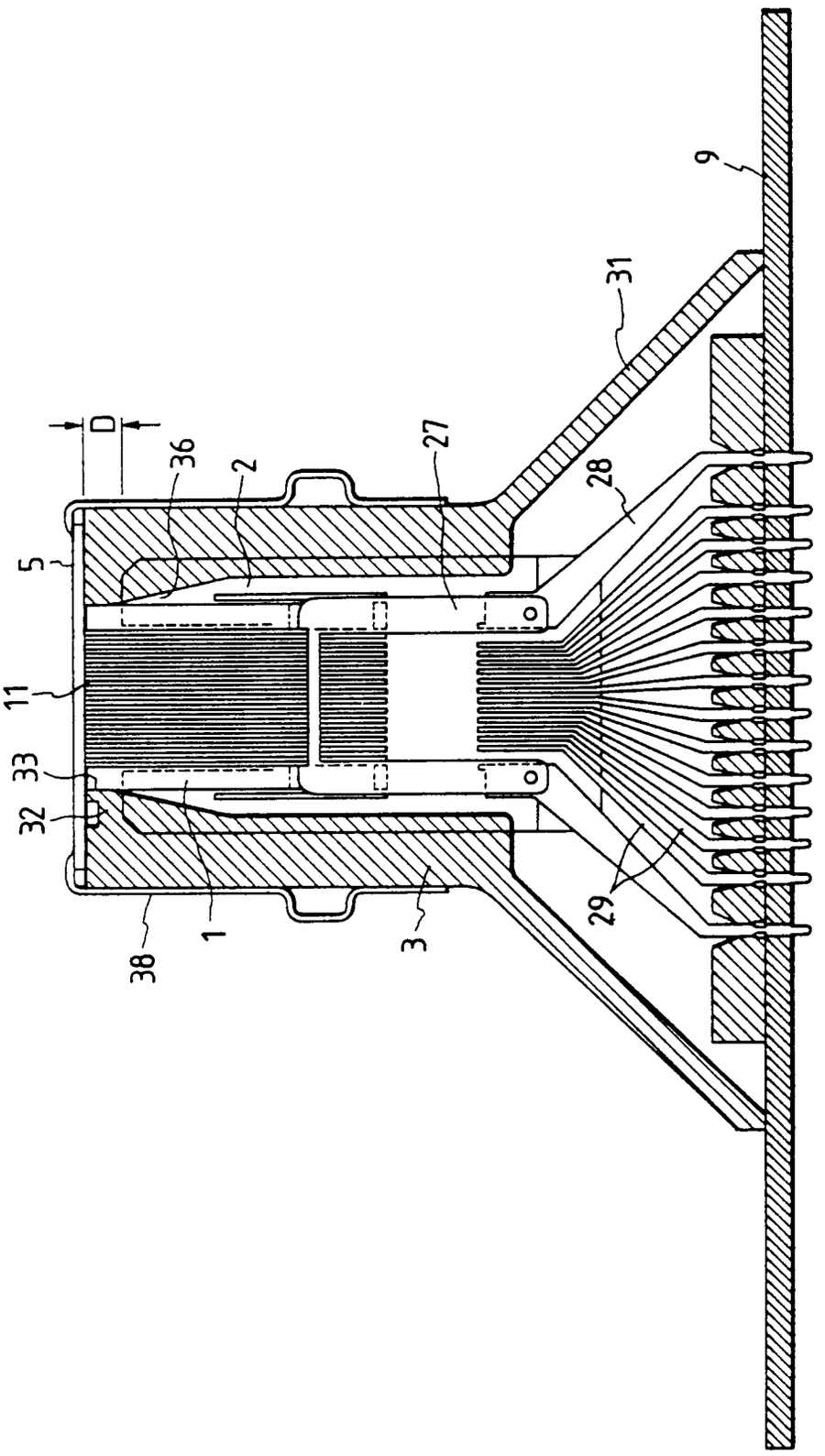

FIG. 2

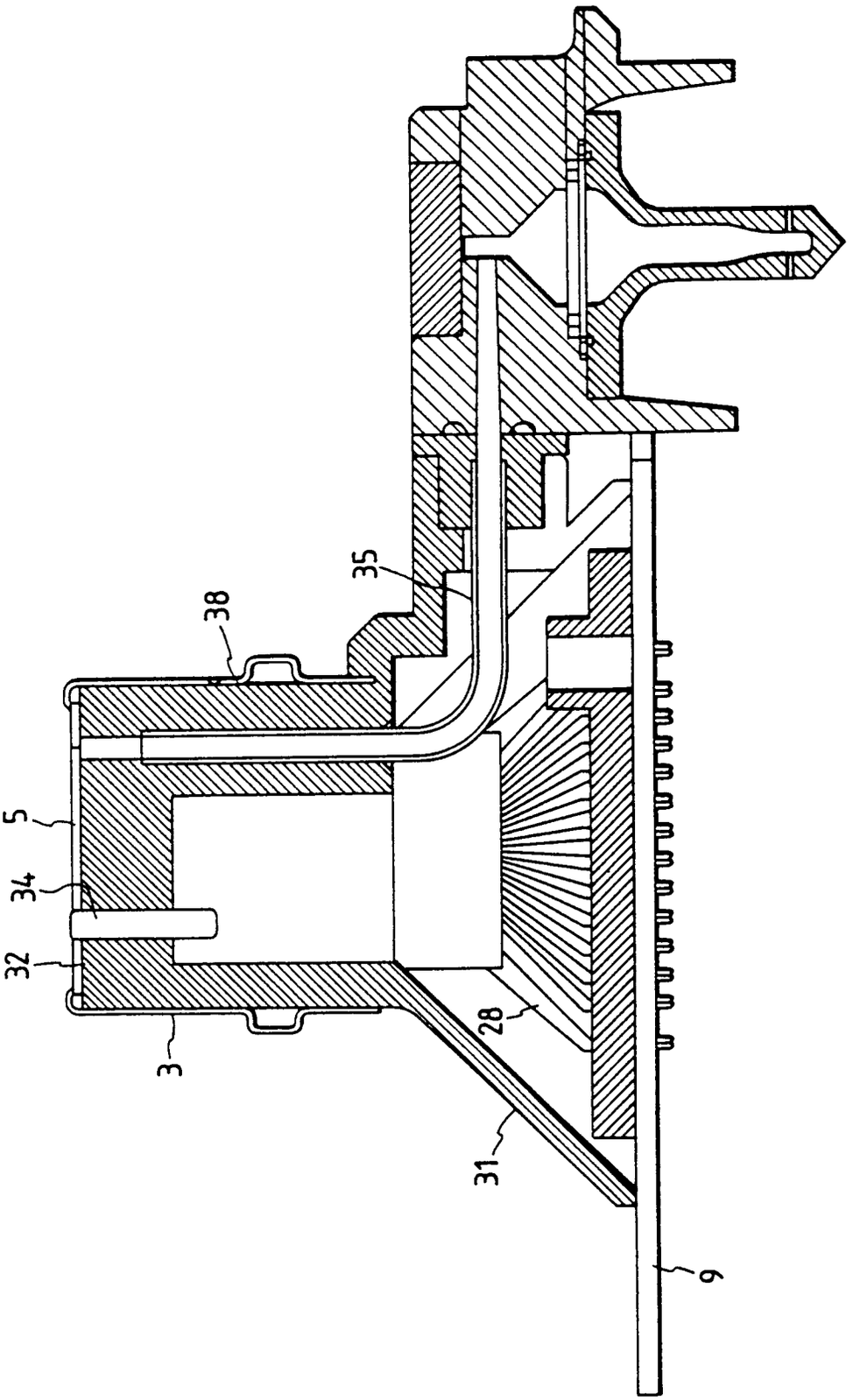

FIG. 3(a)

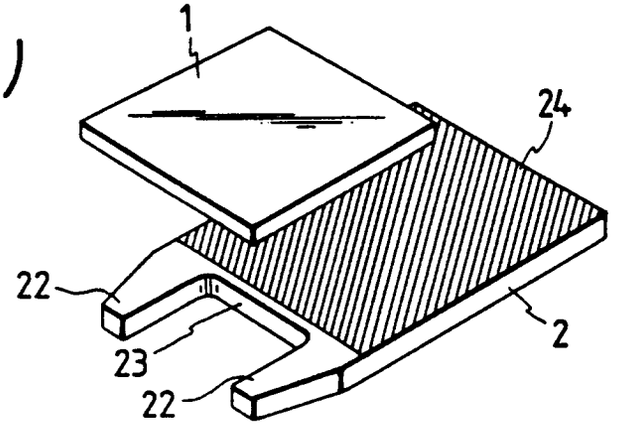


FIG. 3(b)

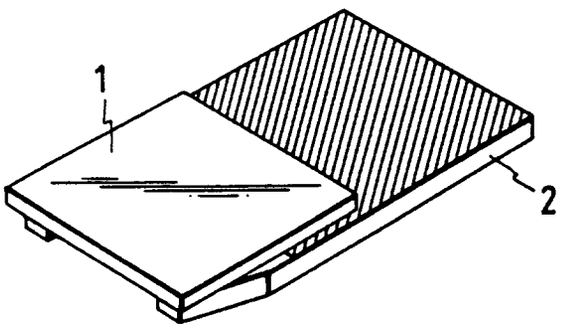


FIG. 3(c)

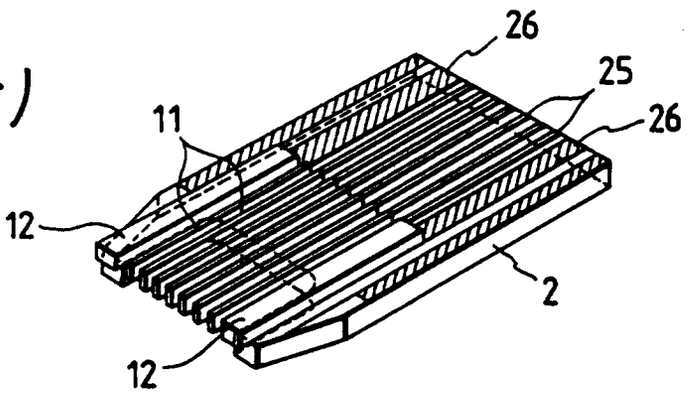


FIG. 3(d)

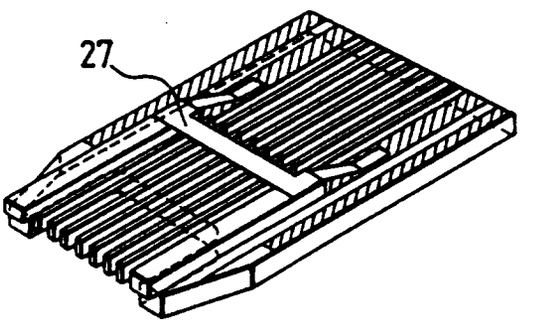

FIG. 4

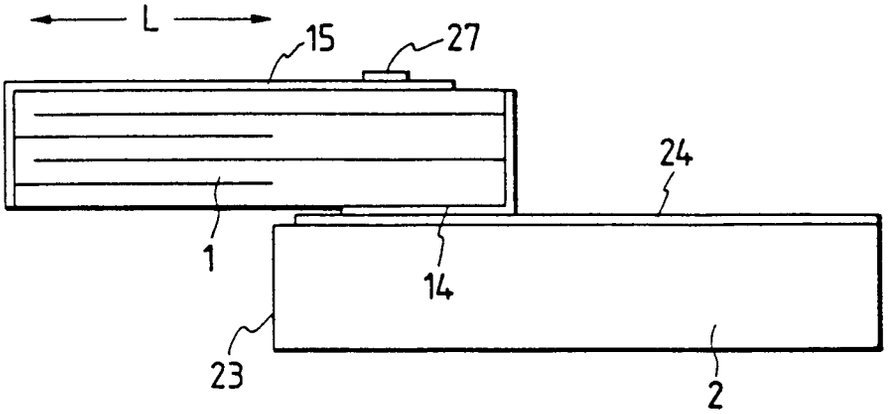


FIG. 5

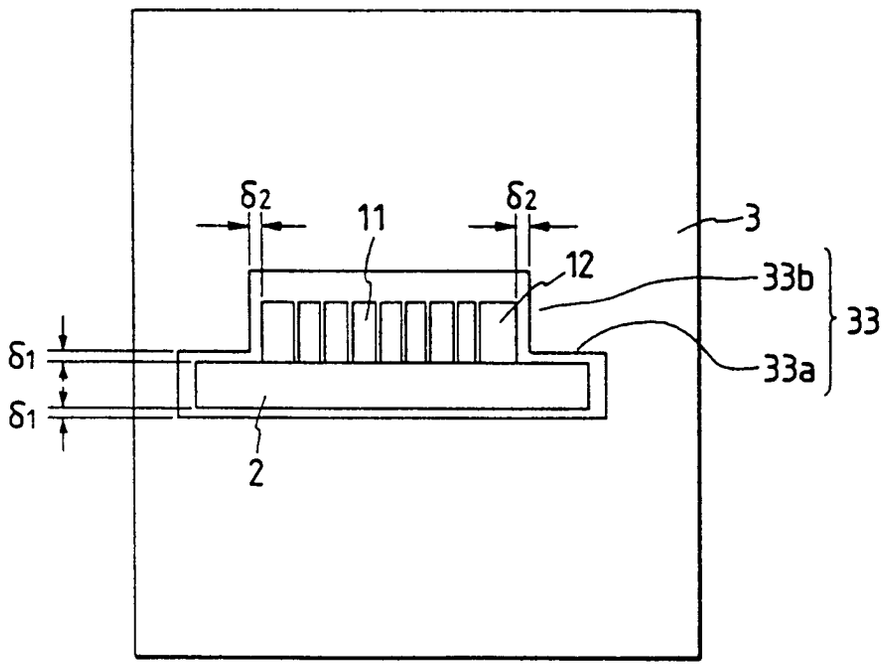

FIG. 6

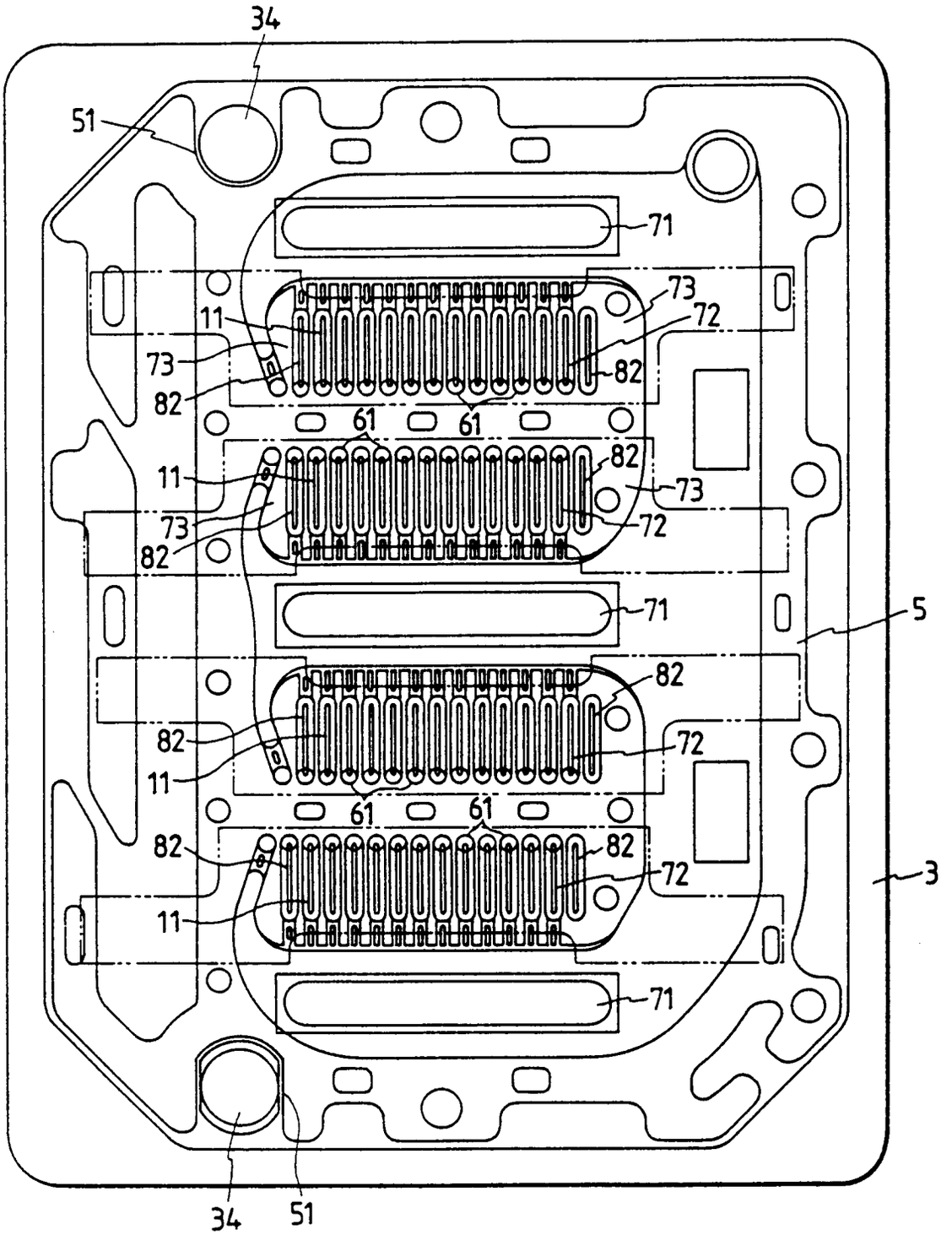
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FIG. 7

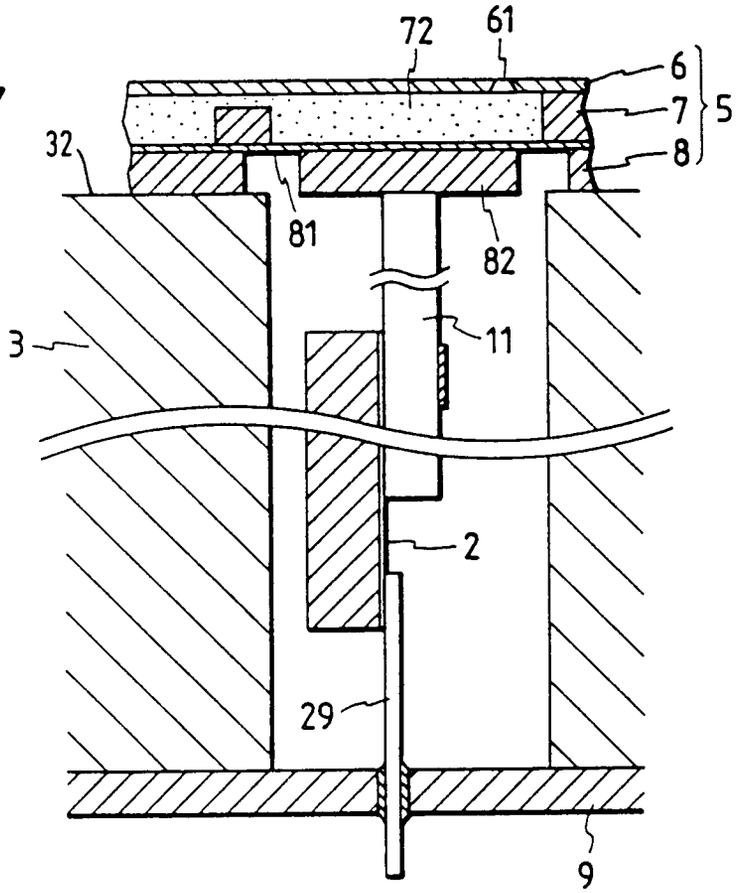


FIG. 8

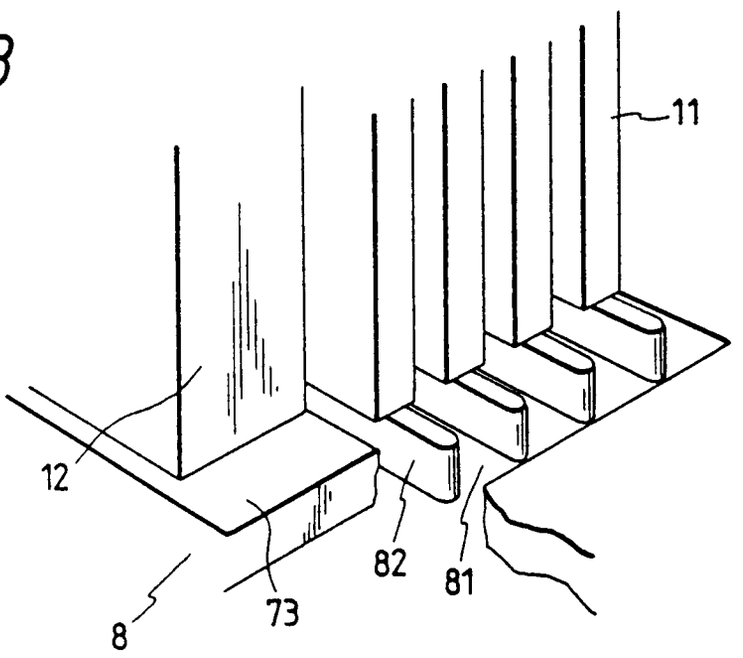

FIG. 9

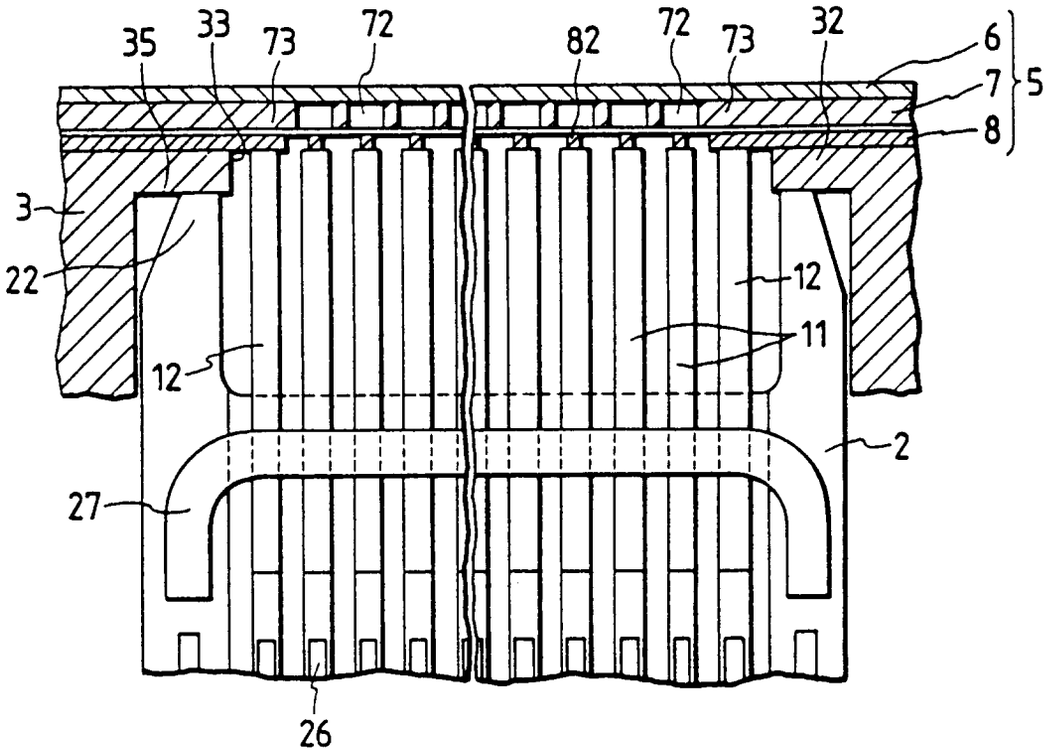


FIG. 10

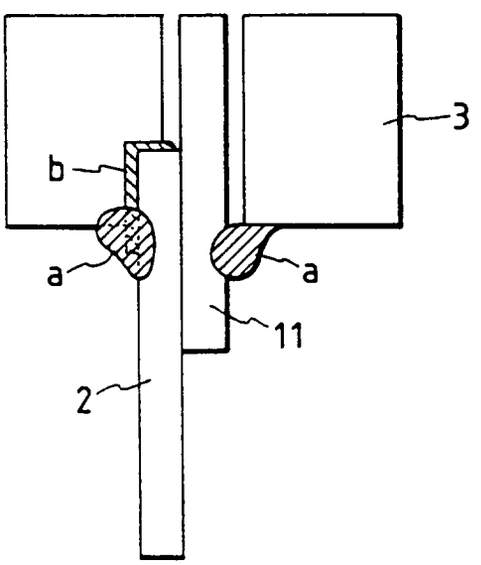

FIG. 11

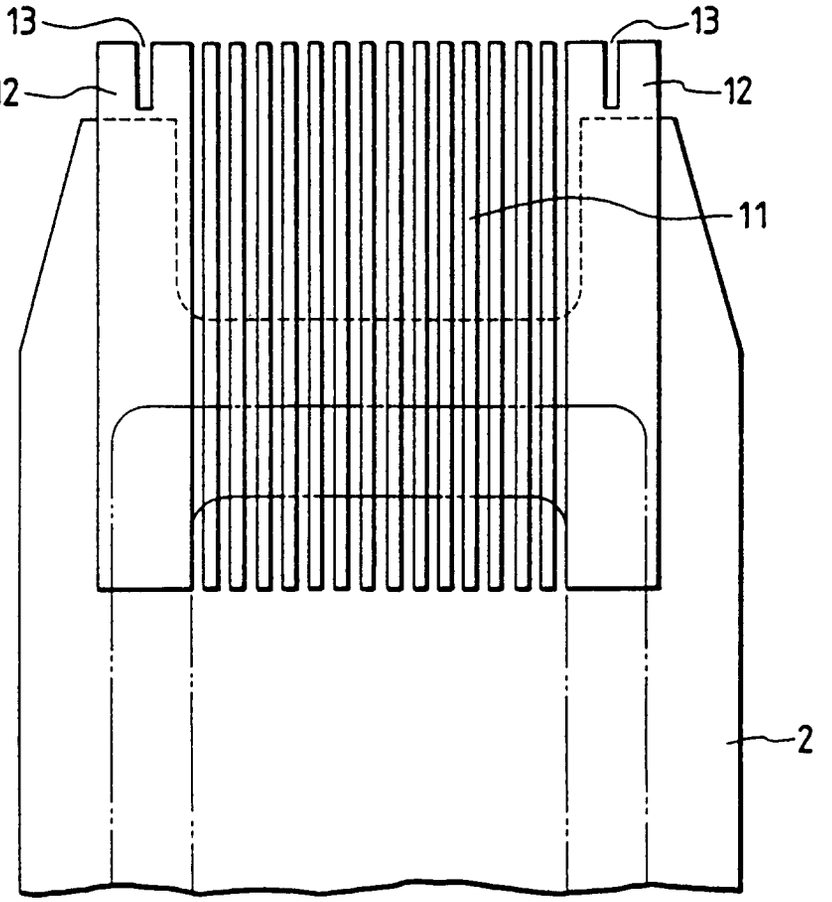


FIG. 12

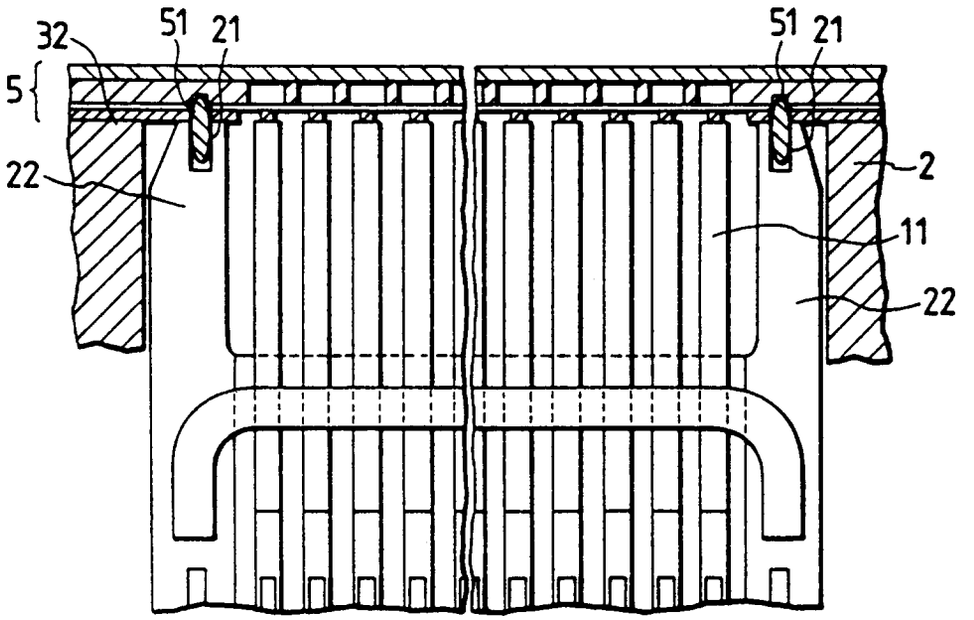

FIG. 13

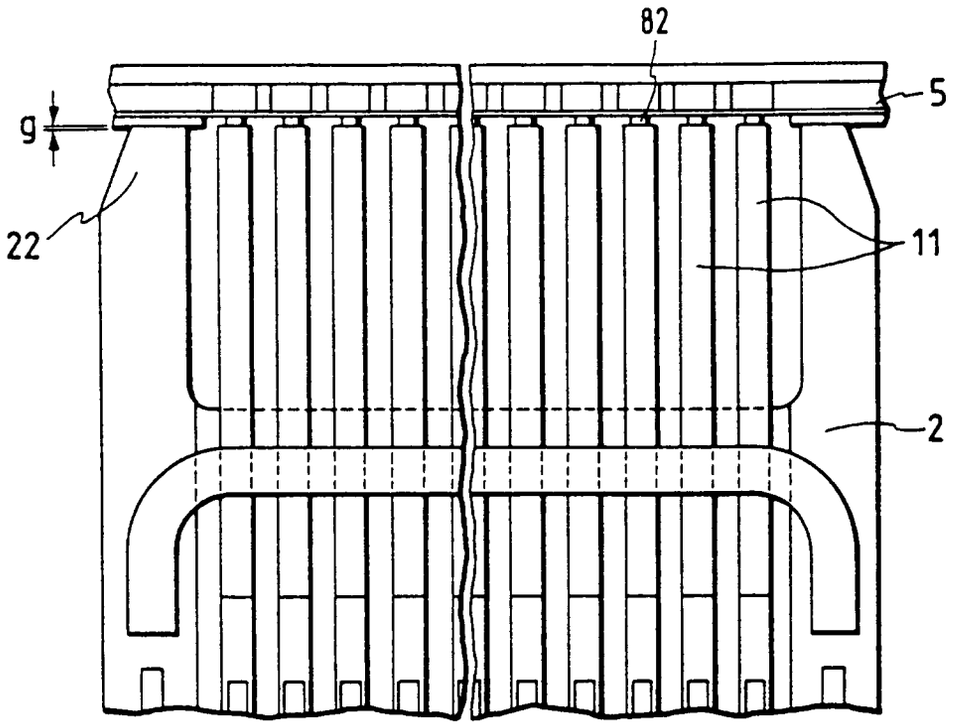


FIG. 15

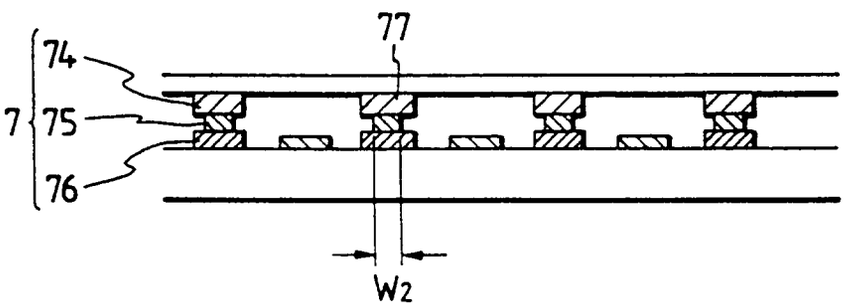

FIG. 14(a)

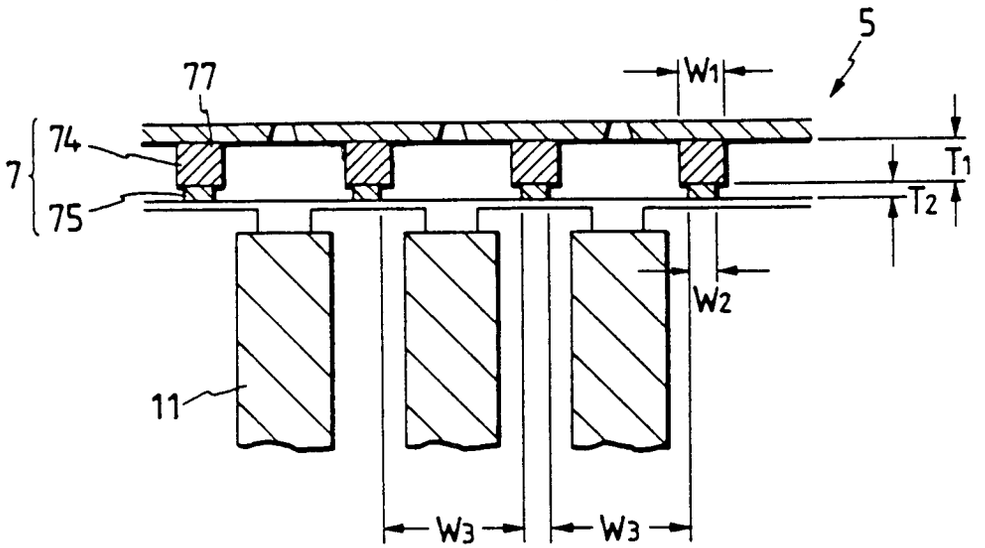


FIG. 14(b)